

Implementing Japanese lesson study: An example of teacher–researcher collaboration

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There is growing worldwide interest in Japanese lesson study as a model for professional learning, with large-scale adaptations of lesson study taking place in many countries. This paper describes how teachers and researchers collaborated in a lesson study project carried out in three Victorian schools. It describes Japanese lesson study and the typical structured problem-solving research lesson that forms the basis for lesson study; and discusses how the collaborative planning process and the resulting research lessons, together with the post-lesson discussions, provided teachers and researchers with the opportunity to collaborate in the research process.

Japanese lesson study

Japanese lesson study is a professional learning activity with origins that can be traced back for almost a century. Unlike many Western initiatives, richly funded and mandated, lesson

study in Japan is neither funded nor mandatory. Essentially school-based and organised by teachers themselves, it pervades primary school education—and to a lesser extent secondary school education—across the country, with teachers researching their own practice in school-based communities of inquiry.

Lesson study first came to worldwide attention as a vehicle for professional learning through Yoshida's (1999) doctoral dissertation and Stigler and Hiebert's (1999) accounts of Japanese structured problem-solving lessons based on the Third International Mathematics and Science Study (TIMSS) video study. Since then, there has been phenomenal growth of lesson study as a vehicle for professional learning in countries such as the USA, UK, Malaysia, Indonesia and Australia.

Japanese lesson study has four components:

- formulation of over-arching school goals related to students' learning and long-term development;
- group planning of a research lesson addressing these goals;
- one team member teaching the research lesson while the planning group, and others, observe in order to gather evidence of student learning; and
- the post-lesson discussion where the planning group and other observers (usually including an 'outside expert') discuss and reflect on the evidence gathered during the lesson, using it to improve the lesson, the unit, and instruction more generally (Perry & Lewis, 2008, p. 366).

In Japan, the research lesson in mathematics is based on 'structured problem solving', a major instructional approach designed to create interest in mathematics and stimulate creative mathematical activity (Takahashi, 2006). Typically such lessons have four stages: posing the problem; students solving problems individually, in pairs or small groups; whole-class discussion; and summing up (Shimizu, 1999). These lessons have a single focus and address a single problem designed to "achieve a single objective in a topic" (Takahashi, 2006, p. 4).

Critical in the process of planning a research lesson is the selection of the problem or task for the problem-solving activity through *kyozai-kenkyu*, which is an intensive and complex investigation of a large range of instructional materials, including textbooks, curriculum materials, lesson plans and reports from other lesson studies, coupled with a study of students' prior understandings (Watanabe, Takahashi & Yoshida, 2008). While teachers cannot engage every day in such deep *kyozai-kenkyu*, conducting it for the purpose of a research lesson leads to a deeper understanding of the curriculum and the mathematical content and goals underpinning it, as well as the importance of matching problems to both the mathematical goals of the lesson and students' knowledge (see also Doig, Groves & Fujii, 2011).

Public observation and debriefing of research lessons is a key feature of Japanese lesson study. Typically a research lesson will be observed by all members of the lesson planning team, the school principal, the other teachers at the school (or the other teachers in the same subject area at secondary schools), and an 'outside expert' who acts as the final commentator at the post-lesson discussion. Depending on the scale of the research lesson, there may be many additional outside observers—50 to 100 observers would not be unusual. Observers focus on student learning and are expected to base their comments in the post-lesson discussion on evidence they have collected during the lesson. The purpose is to promote thoughtful, data-focussed discussion of the lesson.

Teachers act as researchers in all phases of the Japanese lesson study process, researching the curriculum, teaching resources, known student misconceptions, and formulating their own research questions to be addressed through the research lesson and subsequent post-lesson discussion.

Our lesson study project

The *Implementing Structured Problem-solving Mathematics Lessons through Lesson Study* project worked with two Year 3 or 4 teachers from each of three schools from a Melbourne school network to explore ways in which key elements of Japanese lesson study could be embedded into Australian mathematics teaching and professional learning. Teachers were supported not only by members of the Deakin research team, but also by a key leading teacher at each school (e.g., a curriculum specialist or numeracy coach) as well as the network numeracy coach—a total of ten participants.

Participants took part in an initial whole-day professional learning session on lesson study in June, and completed one lesson study cycle during each of Terms 3 and 4 of 2012. Each lesson study cycle involved two cross-school teams of three teachers and two leading teachers or coaches planning a research lesson on the same topic during four two-hour planning sessions. Each team was supported by two of the university researchers. One member of each team taught the research lesson in front of observers, with both teams participating in the post-lesson discussions. Key staff at each school, together with all interested teachers who could be released from their classes at the time of the research lessons, as well as other professionals such as numeracy coaches and leadership teams from other network schools, and mathematics educators, were invited to observe the lessons and take part in the post-lesson discussions. Approximately 30 people observed the fourth research lesson in December 2012. Due to the perceived success of the project, the project has continued into the first half of 2013, with two days of teacher release for each participating teacher being funded by the Melton Network. Two research lessons are now being planned for the second week of Term 2.

In this paper, members of the Deakin University research team discuss how the collaborative planning process and the resulting research lessons, together with the post-lesson discussions, provided teachers and Deakin researchers with the opportunity to collaborate in the research process, while one of the school numeracy coaches and the network numeracy coach provide their perspectives on the project.

The collaborative planning process

Detailed and careful planning is central to the Japanese lesson study process. Planning for lesson study in a Japanese school involves setting overarching goals, as well as goals for the unit of work in which the research lesson is embedded, and goals for the research lesson itself. Teachers need to identify key mathematical ideas to be explored in the lesson and anticipate students' mathematical solutions. In keeping with the spirit of Japanese lesson study, which sets out to engage teachers as "investigators of their own classroom practices" and "researchers of teaching and learning in the classroom" (Takahashi & Yoshida, 2004, p. 438), teachers and coaches took full responsibility for the planning of the research lessons. The Deakin research team facilitated the planning process by sourcing potential mathematical tasks to be explored, modelling a problem-solving lesson using a problem similar to the one to be used in the first research lesson, and providing resources such as articles on lesson study and sample lesson plans.

During the first planning meeting in each cycle, teachers and numeracy coaches in the project engaged in solving the mathematical problem proposed for the research lesson and participated in a discussion of their solutions. Having first-hand experience in solving the mathematical problem and discussing the attributes of various solutions was instrumental in helping teachers anticipate the learning potential for students and possible misconceptions students might have when working on the problem. Furthermore, engaging in solving the mathematical problems provided teachers with opportunities to deepen their mathematical content knowledge.

Anticipating students' solutions is a key element of the lesson planning process in Japanese lesson study (Shimizu, 2009). It gives teachers a clear idea of what to look for when they observe students' work, thus enabling them to orchestrate a productive whole-class discussion that carefully sequences students' solutions. The main teaching and learning takes place during this whole-class discussion, which is designed to help students learn something 'new' and advance their mathematical thinking. (Shimizu, 2009; Takahashi, 2006; Watanabe, Takahashi & Yoshida, 2008).

Anticipating students' mathematical solutions was a new element in the planning process for all teachers and coaches. Similarly, orchestrating an extended whole-class discussion was not a common practice in their mathematics lessons. Initially teachers expressed concern about allocating 20 minutes for a whole-class discussion and predicted that this would be challenging for their students. In order to allow teachers to become more familiar with such a lesson structure and to build their confidence in implementing such lessons, the research team encouraged teachers to work closely with their school numeracy coach in trialling a similar problem-solving task in their classrooms. Teachers in both planning teams agreed to trial another problem with their class and record students' responses. As a result, teachers became more comfortable with conducting extended whole-class discussions, with one teacher commenting that she had been "quite wrong" when she had previously predicted that her class would not be able to come up with many different solutions or be able to spend extended time sharing these. This was a major breakthrough for this teacher. Other teachers came to similar conclusions after trialling the research lessons in different classes prior to the research lesson day. Sharing the insights gained from trialling these problem-solving lessons in the planning meetings was instrumental in advancing the planning process. Through this trialling process, teachers were encouraged to examine in detail various elements of the research lessons, such as the exact phrasing of the task, ways to elicit students' mathematical thinking through questioning, and planning the sequence of students' solutions to enable a progression of ideas.

At the beginning, there might have been an expectation that the researchers would lead the way in planning the research lesson. However, members of the planning teams shared responsibilities to identify links between lesson goals and curriculum documents. Collective effort by every member was evident through the sharing of resources. The numeracy coaches played a salient role in supporting teachers to conduct the trial lessons by arranging a release time for teachers to observe each other's trial lessons, analysing students' work and helping teachers to plan questions to elicit students' thinking. The fact that members of the research team stepped back and let the teachers and coaches take control of the planning process was initially

challenging for some teachers. However this thinking had shifted by the end, after teachers had observed the benefits of developing their own clear ideas about different elements of the lesson through the process of articulating their thoughts and ideas, guided by questions from members of the research team. There was a strong sense of mutual trust among members of the planning teams, driven by the intention to work on common goals to generate knowledge by examining classroom practice with questioning attitudes, an indication that the planning teams were working as communities of inquiry (Groves, Doig & Splitter, 2000; Jaworski, 2008).

In-depth planning of a research lesson requires a large time commitment. While teachers and coaches saw the real benefits of in-depth planning in deepening teachers' knowledge of mathematics and in the changes to their lessons, ways to address the common concern about the amount of time and continued support from the school community required remain to be explored.

Teachers as researchers

On the surface, Japanese lesson study would not appear to be related to teachers acting as researchers. However, examining one's practice is a core aim of the research lesson. The purpose of the research lesson in Japanese lesson study is not to provide "a demonstration that showcases a particular teacher or approach" (Watanabe, 2002, p. 37), but rather to provide a proving ground or test-bed for an experiment in teaching and learning. While this may seem a grandiose claim for a single lesson, albeit well-designed and taught, Lewis and Tsuchida (1998) report that "Japanese teachers repeatedly pointed to the impact of 'research lessons' ... as central to individual, schoolwide and even national improvement of teaching" (p. 12).

How does this work? In a Japanese lesson study cycle, teachers in the planning group choose goals and design a lesson to achieve these goals. The goals may be to improve student attitudes to mathematics, to develop new skills, or to try an alternative approach to a curriculum topic. In most cases, the goals include one that is directed towards developing student understanding. For example, in our project, the task in one research lesson was to find the number of dots in a 23×3 array, without counting the

dots individually. One of the two planning teams listed the following as their two goals for their research lesson: "to encourage students to use more effective multiplicative thinking strategies (including the use of arrays and partitioning); and to ensure students' mathematical explanations match their use of the diagram".

These goals reflect the planning group's own goals or research questions, one of which was "to build the content knowledge of teachers as well as their capacity to ask more precise questions about the student responses". In their lesson plan, this group included a section on how these lesson goals related to their own lesson study goals, stating that:

In this lesson we are looking at how the teacher poses the problem in order to elicit student thinking about multiplicative strategies. The teacher questioning and discussion should progress student thinking at their point of need and the collaborative planning for this lesson should result in improved teacher practice and student learning.

Although the teachers' research questions are phrased as goals, it is clear what the teachers planning the research lesson wish to investigate.

Once the planning group has agreed on the goals, the lesson plan starts to take shape. A critical feature of the planning is to anticipate likely student solutions. Without a tradition of such lessons to fall back on, teachers in the planning groups trialled the task in their own classrooms, in order to identify likely solution strategies. Researching likely solutions to a problem is a feature of planning for a research lesson, revealing to the inquiring teacher not only many aspects of how children interpret tasks, but also the range of strategies that students employ in solving the problem. In the problem involving finding the total number of dots in the 23 by 3 array, teachers' research in their own classrooms found the following strategies used by the Year 3 and Year 4 students: counting all the dots; using repeated addition; skip counting by threes; writing the number sentence $23 \times 3 = 69$; and using the vertical multiplication algorithm. While some teachers were surprised with the range of strategies found, others were surprised at the achievement of some of their thought-to-be less capable students. As teachers gained more interesting insights into their students' thinking, this also honed the questions

to be used within the lesson itself, as teachers discovered the effect of using different wordings of the task on student responses. This emphasis on deciding on an exact wording to a task in order to stimulate desired responses from students took on a life of its own and became a major influence in creating later lessons.

Finally, the observers invited to the research lesson (a hundred extra eyes) were asked by the planning team to look for evidence that would support the achievement of their goals for the research lesson, thus helping the teachers gauge the effectiveness of their endeavour. For example, the planning team referred to earlier, stated:

We would like the observers to focus on one or two students to collect data on the strategies used in the lesson. Specifically we would like to know if the strategy used by the students matches their recorded method using the diagram and if the student is chosen to share, how well does the student articulate the strategy used and recorded method?

Over the complete lesson study cycle, teachers were continually investigating “What would happen if we...?” and worked on answering their own questions. In a presentation at the 2012 Mathematics Association of Victoria annual conference, two points were highlighted that under-scored the heightened interest in researching practice by the lesson study project teachers, namely the benefits to teachers and students coming from: planning in teams with clear lesson goals; and trialling lessons before conducting them.

In this project, it was apparent to both the teachers and the university academics, that the teachers were researchers in the project just as much as were the academics.

Creekside College: A need for lesson study

As a numeracy coach in a school of over 1400 students, leading the development and evolution of a problem-solving culture in mathematics looms as a challenging task. For teachers to teach through problem solving, rather than the more commonplace ‘teach a problem-solving strategy a week’ approach, it is vital to build a collaborative, learning community model

for planning mathematics units and lessons. Teams of teachers need to work as professional learning communities, where their mathematical knowledge for teaching is developed collaboratively and in an ongoing way, enabling them to teach within a problem-solving paradigm of mathematics teaching and learning. If building teachers’ mathematical knowledge for teaching is the priority, then Japanese lesson study offers a model within which this can take place. Lewis, Perry and Murata (2006) outline the conjecture that more than simply planning a lesson, lesson study strengthens three pathways to instructional improvement (see Table 1).

Table 1. Lesson study strengthens teachers’ mathematical knowledge for teaching (Lewis et al., 2006, p. 5).

Teachers’ knowledge	Teachers’ commitment and community	Learning resources
Knowledge of subject matter	Motivation to improve	Lesson plans that reveal and promote student thinking
Knowledge of instruction	Connection to colleagues who can provide help	
Capacity to observe students	Sense of accountability to valued practice community	Tools that support collegial learning during lesson study
Connection of daily practice to long-term goals		

Although the success of Japanese lesson study as a model for improving instruction and teacher content knowledge in Japan has been well-researched and documented, the ability of non-Japanese schools and systems to adopt it as successfully must be considered. Lewis, Perry, Hurd and O’Connell (2006) conducted research into the effectiveness of North American schools and districts in utilising and adapting a lesson study approach to improve teacher instruction and student achievement. They found a distinct improvement in student achievement data in mathematics with the inception of their lesson study approach. Teachers also commented on the enhanced collaboration and development of collective efficacy in the culture of the school. While the whole process is built strongly around the established lesson study processes of Japan, the schools in the United States were continuously mindful of making it work in the USA, not simply replicating the exact program as observed.

This not only allowed the schools to develop a model that worked for them, but also allowed the schools, teachers and professionals involved to take ownership of the lesson study process. It is these two key pieces of research that have lead me to believe that incorporating aspects of lesson study, if not entire lesson study cycles, into the established planning and teaching practices of Creekside College teachers would be a key strategy in the improvement of mathematics teaching and learning at our school. The project with Deakin University therefore provided the perfect catalyst for change.

A school-based coach's experiences of the lesson study project

The opportunity to take part in the lesson study project provided a rich experience with myriad benefits, challenges and future implications for both my coaching practice and the teaching and learning practice of the teachers involved in lesson study. Successes of the project included, but were not limited to:

- collaborative planning within a team;
- exploration of developmental continua throughout the planning meetings;
- increased mathematical knowledge for teaching, reported by all teachers at the conclusion of each lesson study cycle;
- the opportunity to work with 'more experienced others' throughout the planning process;
- planning, teaching and reflecting on a problem-solving approach to mathematics;
- modifications to the established lesson structure to incorporate more teaching taking place through reflection and sharing;
- consideration and planning for anticipated student responses to the problem throughout the planning process;
- building the confidence of the classroom teachers involved in the project;
- careful, more deliberate task selection, design and modification to meet the learning goals of the lesson and unit;
- the rigorous nature of the planning documentation;
- the honest and open nature and culture of the post-lesson discussion, enabled by the thorough discussion of the lesson, lesson plan, teaching and learning; and

- multiple cycles allowing all involved to hone skills and reflect on learning through the new implementation.

Future implications for mathematics teaching and learning at Creekside College as a result of the lesson study project included, but were not limited to:

- extending share time to around fifteen to twenty minutes in most numeracy lessons;
- student solutions being deliberately selected and ordered across a continuum of learning rather than just having a student read out their own work;
- use of moderation of problem-solving tasks as a pre-assessment for units;
- running lesson study teams throughout the year;
- eventually having each team of teachers running a lesson study cycle;
- importance of teachers planning in a way that builds their knowledge of misconceptions and how they teach through these; and
- in my role as coach, leading the development of teachers' task design and questioning skills.

It is important to conclude with a reflection on why this project was so important and what it means for the future. I feel vindicated in my belief that if we can develop a planning model where teachers can build their knowledge for teaching, then we can improve teachers' practice and, most importantly, improve student learning. The ability of this project to bring together mathematics researchers, numeracy leaders and classroom teachers was a vital component in 'launching' lesson study. Merely reading about it and then trying to implement it within schools would not do the process justice. Having researchers who have been involved in lesson study—on multiple occasions, in multiple schools, across a number of years and countries—allowed us to run an authentic lesson study, the benefits of which are countless. A project, which allowed teachers to engage in their own research hand in hand with more experienced others, provided ongoing opportunities for self-reflection and the ability to engage in a genuine professional learning community. I see my role as one where I 'teach a man to fish' rather than give him a fish. Without this view, I believe teachers will never gain the knowledge and confidence to teach high quality mathematics programs and engage learners as problem solvers. Leading and empowering others in collaborative learning communities

is essential if long-term, sustainable change is going to occur. Lesson study provides one such paradigm, and this project has been the catalyst for establishing lesson study cultures in our Australian schools.

Perhaps the most significant ‘product’ of the lesson study project for Creekside College is the implementation of our first lesson study cycles within the school in 2013. A group of six teachers from across different year levels will be engaging in a full lesson study cycle each term throughout the year. It is hoped that this will become part of the culture of not only mathematics teaching and learning practice, but also an in-built component to quality teaching and learning practice across all curriculum areas into the future.

Lesson study in the Melton Network

As a numeracy coach to over 20 schools across the Melton Network in the Western suburbs of Melbourne, I have been trying for many years to implement the concepts underpinning Japanese lesson study. Last year I got the opportunity to act as a project facilitator in an authentic lesson study project. This involved inviting three schools in my network to become involved in Deakin University’s project. Considerations included finding three schools in close proximity to each other to overcome travelling issues; teachers were able to move between schools during their lunch break. The first step was to convince the school-based numeracy coach and the leadership team at each school that this was a worthwhile project. As the facilitator of the school-based numeracy coaches’ professional learning in my network, I had previously discussed the merits of a lesson study approach to develop teacher content knowledge. So with Deakin University support of funding and personnel this was an easy task and all schools approached were extremely eager to be involved. All school numeracy coaches and leadership teams within the network were invited to attend each research lesson. While not all attended, those who did were excellent advocates for the process and soon there was a need to give all principals within the network some professional learning around the lesson study process. As a result the Melton Network of schools agreed to support the original schools in continuing a

final lesson study for Term 1 in 2013 so that all six classroom teachers in the project could have the opportunity to conduct a research lesson.

As a result of the professional discussions and participation in the lesson study project, schools involved in the project have:

- created greater levels of collegiality between teachers and schools involved in the project;
- helped to build a common professional language and common understanding of high quality pedagogy;
- provided opportunities for teachers to share high quality teaching practice, thereby providing a forum to share ideas, success and challenges;
- had a reason to learn together as a result of participating in a practical project that will help improve student learning;
- had to carefully prioritise the most important themes to tackle in the research lesson;
- shared collective responsibility for producing more effective learning for all students;
- used and built on what they know;
- created and implemented plans for achieving their project aims—they think big, but start small and manageable;
- identified the professional learning strategies that most help them learn; and
- combined outside-provided support (research findings, Network Numeracy Coach, external consultants—Deakin University) and work-embedded support (lesson observations, team-teaching, coaching).

While there have been numerous benefits from involvement in this project for both the network and the schools involved, the next challenge is to sustain this work. As my role as network coach is funded through National Partnerships funding, it is unlikely it will continue after this year. Many schools are placing their full time school based numeracy coaches back into a full time classroom role and therefore won’t have the time to support the intensive planning needed to develop research lessons. External funding from both Deakin University and, this year, from Melton Network has definitely been a huge reason for the success of this project. However, I am confident that all schools involved in the project will try to modify and implement many of the aspects of lesson study they have experienced through their involvement in this project.

Conclusion

In Japan, lesson study is the main form of systematic professional learning undertaken by teachers. Outside Japan, lesson study is sometimes understood superficially as an activity aimed at perfecting individual lessons. However, it should rather be seen as an activity that allows teachers to collaborate with one another to research their own practice. For example, Lewis and Tsuchida (1998) quote a teacher as saying:

Research lessons help you see your teaching from various points of view... A lesson is like a swiftly flowing river; when you're teaching you must make judgments instantly. When you do a research lesson, your colleagues write down your words and the students' words. Your real profile as a teacher is revealed to you for the first time (p. 15).

Lesson study in Japan usually involves the participation of outside experts—typically educational consultants, district personnel, or university academics. While these outside experts may only participate in the post-lesson discussions, their contributions help teachers reflect on their practice and often inject new knowledge about relevant research findings. Findings from our project suggest that lesson study in Australia can also provide the opportunity for genuine teacher–researcher collaboration.

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